

## SPECIFICATION AMENDMENTS

Please amend the specification as follows:

Page 6, please substitute the following for the paragraph beginning at line 15 and ending at line 23:

One application of the proposed invention is the enhancement of well-known photoactive semiconductor devices, such as Si photovoltaic cells using nanoscale biophotonic constructs that are either acquired, harvested or otherwise manipulated in their natural or adapted state using the method and apparatus described herein to achieve desired FoM performance characteristics. Although commercially available Si photovoltaic cells have been employed in various devices and applications for years, their ~~FOM's~~ FoMs are typically low despite detailed knowledge of their structure and function and the ability to prescribe device performance specifications from use of selected light wavelengths throughout the visible spectrum, as well as, related device specifications associated with the engineering transfer function.

Page 10, please substitute the following brief description of the drawings for Figs. 4 - 9, lines 14 through 24:

Fig. 4 is a cartoon schematic rendering of a ~~chlorosome~~ chlorosomes of *C. aurantiacus* in place ~~[[on]]~~ in a ~~sitoplasmie~~ cytoplasmic membrane;

Fig. 5 is a diagrammatic (cartoon) illustration of a chlorosome ~~an RC<sup>+</sup> whole-cell fragment~~ of the bacterium *C. aurantiacus* ~~and its chlorosome-RC<sup>-</sup> with its four major subunits~~ (the chlorosome designated herein the RC<sup>+</sup> chlorosome);

Fig. 6 is a diagrammatic (cartoon) illustration of the chlorosome ~~[[RC]]~~ of the bacterium *C. aurantiacus* of Fig. 5, but with two of its four subunits, the B808/866 protein light harvesting

apparati and a reaction center removed (the chlorosome thus modified designated herein the RC<sup>-</sup> chlorosome);

Fig. 7 is a diagrammatic (cartoon) illustration of the chlorosome of Fig. 6 with parts broken away for clarity showing contained rod-like structures of Bchl c;

Fig. 8 is a functional block diagram in the form of a flow chart of optical interactions of the components of the ~~whole cell fragment~~ chlorosome shown in Fig. 5;

Fig. 9 is a plot of absorbent spectra data for ~~the whole cell fragment~~ a C. aurantiacus chlorosome of Fig. 5;

Fig. 9A is an exemplary normalized absorbance spectra plot of the RC<sup>-</sup> chlorosome;

Pages 12 and 13, substitute the following for the paragraphs beginning at page 12, line 12 and ending at page 13, line 15:

The bacteria, *Chloroflexus aurantiacus* (*C. aurantiacus*), strain J-10-f1, has the American Type Culture Collection (ATCC) designation number 29366, having been deposited in July, 1976. The ATCC is located at 10801 University Boulevard, Manassas, Virginia 20110-2209 U.S.A. [[]] The *C. aurantiacus* bacteria is a green, nonsulfur, flexing/gliding, photosynthetic bacteria. [[]] It is thermophilic and can be found in hot springs up to temperatures of 70°C in large mat-like layers. The layers, when concentrated enough, have an orange coloration.

A freeze fracture image of *C. aurantiacus* by scanning electron microscopy (SEM) was taken and is reproduced in Fig. 3. In the image small ovals can be resolved. These are the cell's chlorosomes. [[]] At this size scale ~~however~~, reduction would require specialized EM or other imaging techniques. Thus far, no high resolution structural information has been successfully obtained on individual chlorosome structures, and as such a cartoon schematic representation of the ~~chlorosome~~ chlorosomes 100 in situ is presented in Fig. 4. There, the ~~whole cell fragments~~

chlorosomes 100 are depicted in place in a cytoplasmic membrane 95. A proposed model of a single ~~whole-cell fragment~~ chlorosome 100 is shown enlarged in Fig. 5 in a 3-D cartoon. From the work of Blankenship, et al., the ~~whole-cell fragment~~ chlorosome 100 is comprised of four major sub-units: a Bchl c portion 101, a Bchl baseplate 102, ~~[[a]]~~ B808/866 protein, supra molecular light harvesting complex or apparati 103, and a reaction center (RC) 104.

A chlorosome 110 of the *C. aurantiacus* bacterium is depicted in Fig. 6. It includes two major supra-molecular pigment-protein subunits. These are the bacteriochlorophyll (Bchl) c 101, and the supra-molecular baseplate complex 102. In its form shown in Fig. 5 ~~the whole-cell fragment of the~~ *C. aurantiacus* chlorosome 100 is here designated RC<sup>+</sup> (meaning with its RC 104 and B808/866 light harvesting apparati 103 in place). As depicted in Fig. 6 at 110, stripped of its associated reaction center and B808/866 supra-molecular complex 103, the chlorosome of *C. aurantiacus* is designated RC<sup>-</sup> (meaning without the RC 104 and B808/866 light harvesting apparati 103). Each sub-unit of the ~~whole-cell fragment~~ chlorosome 100 illustrated in Fig. 5 is composed of a large number of wavelength-specific light absorbing and transducing molecules.

Page 14, substitute the following for the paragraphs beginning at line 3 and ending at line 17:

Fig. 9 plots absorbance spectra data of isolated chlorosomes ~~[[RC<sup>-</sup>]]~~ of *C. aurantiacus* noting peaks of interest. There, an absorbance peak at 740 - 750 nm attributable to the Bchl c rods 113 appears. A peak at 795 nm associated with the Bchl a baseplate is shown. In addition absorption of light in the blue region by the carotenoids is evident and blue secondary absorbance peaks from the Bchl c and a (~~designed~~ designated as Soret peaks) occur. A peak attributable to the ~~monomeric~~ monomeric form of Bchl c (like its Soret) has a different absorbance wavelength

peak than the oligomeric form that comprises the rods 113 in the chlorosomes. Like the Bchl a baseplate peak, the Bchl c oligomeric c peak is in the near infrared (NIR).

Absorbance spectra of isolated RC<sup>-</sup> chlorosomes in Tris buffer exhibit the characteristic absorbance peaks (solid line) in the normalized absorbance spectra plot of Fig. 9A.

Immobilizing the RC<sup>-</sup> chlorosomes in PVAc polymer, however, destroyed the chlorosomes as evidenced by the dashed line normalized absorbent spectra plotted in Fig. 9A. This was true of other immobilization attempts with other polymers.

Intact *C. aurantiacus* bacteria display a unique adaptive ability to reversibly and enzymatically assemble and disassemble the foregoing structures to protect the organism from photo-induced damage. As is expected, the spectral peaks of Fig. 6 are highly related to growth conditions of the whole cell *C. aurantiacus* bacteria. ~~There~~ These are also related to the isolation techniques that result in purified chlorosomes. An abbreviated form of the important basic mechanisms of energy transfer that occur between the molecules of the RC<sup>-</sup> chlorosome are as depicted in Fig. 10.

Page 15, substitute the following for the paragraph beginning at line 12 and ending at line 15:

As shown in Fig. 18, when excited with 430nm, 460nm and 470nm, which is exactly where the silicon photovoltaic cells is less sensitive, the RC<sup>-</sup> chlorosome [[RC<sup>-</sup>]] emits at about 810nm where the silicon photovoltaic cell is sensitive. There is, therefore, a spectral enhancement by the addition of the biological component that is similar to that shown generally in Fig. 18.

Pages 15 and 16, substitute the following for the paragraphs beginning on page 15, line 19 and ending on page 16, line 10.

The microslide employed allowed for relatively straightforward application of the chlorosomes. This particular slide has two frosted rings on its surface, one of which is indicated at 131 in Fig. 11. The frosted ring was just sufficiently high above the surface of the slide 120 that a drop of the liquid suspension containing the chlorosomes was retained. The cover glass 118 was rested on the ring 131 and when the suspending liquid had evaporated leaving the chlorosomes adherent to the hydrophobic borosilicate cover glass surface as shown, the epoxy seal 121 was applied. The microwells slide was useful in another respect. Having two of the frosted rings 131, it permitted for the side-by-side construction as illustrated in Fig. 11 and a control. The control could be an identical silicon photovoltaic cell illuminated through the slide 120 and a further glass 118 but absent the chlorosomes, or the control could be as illustrated in Fig. 11 but having the  $RC^+$  chlorosomes ~~fragments~~ entrapped.

In the arrangement of Fig. 11, the  $RC^-$  chlorosomes and the light receiving surface of the photovoltaic cells were no more than a millimeter apart. As indicated in Fig. 11, the construction of the off-the-shelf photovoltaic cell placed the light receiving surface 133 of the silicon semiconductor in a metal housing or can 135 to be exposed through a glass closure 137.

Page 19, please substitute the following paragraph beginning at line 1 and ending at line 10:

Another technique utilized the evaporation procedure as well as an aqueous method to allow incorporation of the  $[[RC^-]]$  chlorosomes onto a glass surface. Both techniques start with taking 0.5  $\mu$ l of a known concentration of the chlorosomes and placing it onto a borosilicate glass coverslip (Fisher Scientific). In the evaporation method, evaporation, under vacuum, is performed overnight and then the sample is sealed onto a fluorescent antibody microslide (Fisher Scientific). In the physical adsorption method, the slide is prepared in the aqueous phase and

inverted during sealing, thus allowing for ensuring a hydrated sample as well as diffusion of the chlorosomes onto the surface of the hydrophobic glass. Samples were also studied under laser scanning confocal microscopy (instrument from LEICA) to investigate orientation and selected function (i.e. stability) was observed with absorbance spectroscopy of the sample afterwards.

Page 30, please substitute the following paragraph beginning at line 12 and ending at line 18:

Processing of the chlorosome requires isolation of the chlorosomes from the whole cell walls ~~as described above and as~~. This is done using a procedure well documented in the literature[.] although certain factors do arise in the process. There are different procedures used to isolate chlorosomes without the reaction centers ( $RC^-$ ) versus those with ( $RC^+$ ). The solvents, agents, and buffer types used in the procedure are also very important and factors such as (the type, molarity, ionic strength, pH, and strength) all come into play. These factors will affect the state of aggregation and purity (and successful use) of the isolated chlorosomes.

Page 41, please insert the following paragraph beginning at line 14 and ending at line 21:

Processing of the chlorosome requires isolation of the chlorosomes from the whole cells. As indicated above, this is done using procedures well documented. Nevertheless certain factors need to be taken into account during this process. These are the different procedures used to isolate chlorosomes without the reaction centers (i.e. the  $RC^-$  chlorosomes vs. the  $RC^+$  chlorosomes). Solvents, agents and buffer types used in the procedure are also important, and factors such as the type, molarity, ionic strength, pH and strength of these all come into play. These factors will affect the state of aggregation impurity of the isolated chlorosomes, and consequently the ultimate success of the design.